

memory device **1030**. In some example embodiments, at least a portion of the methods according to some example embodiments may be performed by hardware implemented in the processor **1010**.

[0161] The memory device **1030** may operate as a data storage for data processed by the processor **1010** or a working memory. For example, the memory device **1030** may store a boot image for booting the electronic system **1000**, a file system for the operating system to drive the electronic system **1000**, a device driver for an external device connected to the electronic system **1000**, and/or an application executed on the electronic system **1000**. For example, the memory device **1030** may include a volatile memory such as a DRAM, a SRAM, a mobile DRAM, a double data rate (DDR) synchronous DRAM (SDRAM), a low power DDR (LPDDR) SDRAM, a graphic DDR (GDDR) SDRAM, or a Rambus DRAM (RDRAM), etc., and a non-volatile memory such as an electrically erasable programmable read-only memory (EEPROM), a flash memory, a phase change random access memory (PRAM), a resistance random access memory (RRAM), a magnetic random access memory (MRAM), a ferroelectric random access memory (FRAM), a nano floating gate memory (NFGM), or a polymer random access memory (PoRAM).

[0162] In some example embodiments, the memory device **1030** may store information including program routines of extracting the first boundary of the first layer from the original image, of converting the original image into the first image based on the first boundary, and of generating the second image by performing the filtering operation on the first image. The memory device **1030** may further store information including program routines of extracting the second boundary of the first layer from the second image, and of calculating the thickness of the first layer based on the first boundary and the second boundary, and may further store information including program routines of calculating the uniformity of the thickness of the first layer. The processor **1010** may control an execution of the program routines.

[0163] The image pickup device **1040** may be one of various input devices. The image pickup device **1040** may receive or obtain the original image, and may provide the original image to the processor **1010**. In some example embodiments, the image pickup device **1040** may include the TEM. In some example embodiments, the image pickup device **1040** may include the SEM.

[0164] The user interface **1050** may include at least one input device such as a keypad, a button, a microphone, a touch screen, etc., and/or at least one output device such as a speaker, etc.

[0165] The connectivity **1060** may communicate with an external device. For example, the connectivity **1060** may communicate according to one of various types of protocols such as universal serial bus (USB), ethernet, near field communication (NFC), radio frequency identification (RFID), a mobile telecommunication like 4-generation (4G) and long term evolution (LTE), a memory card interface. For example, the connectivity **1060** may include a baseband chipset, and may support a communication such as GSM, GPRS, WCDMA, or HSxPA, etc.

[0166] In some example embodiment, the electronic system **1000** may be any computing system, such as a personal computer (PC), a server computer, a workstation, a tablet computer, a laptop computer, a mobile phone, a smart phone,

a personal digital assistants (PDA), a portable multimedia player (PMP), a digital camera, a digital television, a set-top box, a music player, a portable game console, a navigation device, etc.

[0167] In some example embodiment, the electronic system **1000** may be any mobile system, such as a mobile phone, a smart phone, a tablet computer, a laptop computer, a PDA, a PMP, a digital camera, a portable game console, a music player, a camcorder, a video player, a navigation system, etc. The mobile system may further include a wearable device, an internet of things (IoT) device, an internet of everything (IoE) device, an e-book, etc.

[0168] According to some example embodiments, the electronic system **1000** and/or components of the electronic system **1000** may be packaged in various forms, such as a package on package (PoP), a ball grid arrays (BGA), a chip scale packages (CSP), a plastic leaded chip carrier (PLCC), a plastic dual in-line package (PDIP), a die in wafer pack, a die in wafer form, a chip on board (COB), a ceramic dual in-line package (CERDIP), a plastic metric quad flat pack (MQFP), a thin quad flat pack (TQFP), a small outline IC (SOIC), a shrink small outline package (SSOP), a thin small outline package (TSOP), a system in package (SIP), a multi chip package (MCP), a wafer-level fabricated package (WFP), or a wafer-level processed stack package (WSP).

[0169] As will be appreciated by those skilled in the art, the present disclosure may be embodied as a system, method, computer program product, and/or a computer program product embodied in one or more computer readable medium(s) having computer readable program code embodied thereon. The computer readable program code may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus. The computer readable medium may be a computer readable signal medium or a computer readable storage medium. The computer readable storage medium may be any tangible medium that can contain, or store a program for use by or in connection with an instruction execution system, apparatus, or device. For example, the computer readable medium may be a non-transitory computer readable medium.

[0170] The present disclosure may be used in any device, equipment or system for manufacturing the elements and/or the devices, such as an automated system that manufactures and/or analyze any element and/or device including at least one layer, a thickness of which is to be measured, thereby improving efficiency and quality and maximizing productivity and return-on-investment.

[0171] It should be understood that example embodiments described herein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each device or method according to example embodiments should typically be considered as available for other similar features or aspects in other devices or methods according to example embodiments. While some example embodiments have been particularly shown and described, it will be understood by one of ordinary skill in the art that variations in form and detail may be made therein without departing from the spirit and scope of the claims.

1. A method of measuring a thickness, the method comprising:

obtaining an original image of a structure, the structure including a first layer, the first layer including a first